

Appl. No. 10/655,854
Reply to Office Action of July 27, 2005

Docket No. MIT-136AUS

Amendments to the Claims:

This listing of the claims will replace all prior versions, and listings, of the claims in the application:

What is claimed is:

1. (Currently Amended) A multi-layer integrated semiconductor structure, comprising:

(a) a first device layer having first and second opposing surfaces, said first device layer including:

a first substrate having a first surface corresponding to the first surface of the first device layer and having a second opposing surface, the first substrate having provided therein a first plurality of doped regions which form at least part of one or more semiconductor elements;

a dielectric material having first and second opposing surfaces with the first dielectric material surface disposed over the second surface of the first substrate and wherein the second surface of the dielectric material corresponds to the second surface of the first device layer; and

a first conductive via provided in the dielectric material, the first conductive via having a first end electrically coupled to at least one of the first plurality of doped regions and a second end exposed through the second one of the first and second surfaces of the dielectric material;

(b) a conductive interface having a first surface and a second opposing surface with the first surface of the conductive interface disposed over at least a portion of the second surface of the dielectric material ~~first device layer~~ such that at least a portion of the conductive interface is coupled to at least a portion of the first end of the first conductive via in the first device layer;

(c) a second device layer having first and second opposing surfaces, with the first surface of said second device layer disposed over the second surface of the conductive interface, the second device layer including:

a second substrate having first and second opposing surfaces and having provided therein a second plurality of doped regions which form at least part of one or more semiconductor elements;

an insulating material having a first surface disposed against the second opposing surface of the conductive interface and a second opposing surface of the

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insulating material disposed against a first one of the first and second opposing surfaces of the second substrate and wherein the second device layer is secured to the first device layer via the conductive interface; and

a second conductive via provided in the second device layer, said second conductive via having a first end directly coupled to the conductive interface and having a second end coupled to at least one of the second plurality of doped regions such that an electrical communication path between the first device layer and the second device layer is provided by the first conductive via, the conductive interface and the second conductive via.

2. (Previously Amended) The multi-layer integrated semiconductor structure of claim 1 further comprising a first conductive interconnect element disposed in the dielectric material of the first device layer with a first end of the first conductive interconnect element coupled to the first conductive via and a second end of the first conductive interconnect element coupled to at least one of the first plurality of doped semiconductor elements.

3. (Cancelled)

4. (Currently Amended) The multi-layer integrated semiconductor structure of claim ~~3~~1 further comprising a second conductive interconnect having a first portion disposed over at least a portion of one of the second plurality of doped regions and having a second portion coupled to the second end of the second conductive via.

5. (Previously Amended) The multi-layer integrated semiconductor structure of claim 1, further comprising a second conductive interconnect disposed in the second device layer and coupled to the second conductive via provided in the second device layer.

6. (Previously Amended) The multi-layer integrated semiconductor structure of claim 5, wherein the second conductive interconnect is coupled to at least one of the one or more semiconductor elements of the second device layer.

7. (Previously Amended) The multi-layer integrated semiconductor structure of claim 1, wherein

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the second conductive via includes a first end coupled to the at least one of the one or more semiconductor elements in the second device layer and a second end coupled to the first conductive interface.

8. (Previously Amended) The multi-layer integrated semiconductor structure of claim 7, wherein the second device layer comprises a second conductive interconnect having a first portion coupled to the second conductive via and a second portion coupled to at least one element of the second plurality of semiconductor elements such that the second conductive interconnect couples the second conductive via to the at least one element of the second plurality of semiconductor elements..

9. (Cancelled)

10. (Previously Amended) The multi-layer integrated semiconductor structure of claim 9 further comprising a third conductive via provided in the first device layer, wherein the third conductive via is coupled between a portion of the first conductive interconnect and the at least one of the first plurality of doped regions.

11. (Previously Amended) The multi-layer integrated semiconductor structure of claim 10 further comprising a second conductive interface disposed over a first surface of the second device layer and wherein the second conductive via forms at least a part of an electrical communication path between the second conductive interconnect and at least a portion of the second interface.

12. (Previously Amended) The multi-layer integrated semiconductor structure of claim 1, wherein the first conductive via forms at least a portion of a signal path between the conductive interface and at least one of the first and second plurality of semiconductor elements.

13. (Previously Amended) The multi-layer integrated semiconductor structure of claim 12, wherein the second end of the first conductive via is coupled to the at least one element of the first plurality of semiconductor elements.

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14. (Previously Amended) The multi-layer integrated semiconductor structure of claim 1, wherein the first conductive interface comprises copper.

15. (Previously Amended) The multi-layer integrated semiconductor structure of claim 14 wherein the conductive interface is provided as a first conductive interface region and the multi-layer integrated semiconductor structure further comprises a second conductive interface region disposed between the first and second device layers with the second conductive interface region being physically separated from the first conductive interface region.

16. (Previously Amended) The multi-layer integrated semiconductor structure of claim 15, wherein the second interface region includes an adhesive material such that the second interface region secures the first device layer to the second device layer.

17. (Previously Amended) A multi-layer integrated semiconductor structure, comprising:

- at least a first device layer having first and second opposing surfaces, said first device layer including at least a first doped semiconductor region and a first dielectric material disposed about the first doped semiconductor region, said dielectric material having at least a first via-hole with a first conductive material disposed therein to provide a first conductive via having first and second opposing ends; and

- at least a second device layer having first and second opposing surfaces, said second device layer including at least a second doped semiconductor region and including a second via-hole having a second conductive material disposed therein to provide a second conductive via having first and second ends ;

- a first interface disposed between a first one of the first and second opposing surfaces of the first device layer and a first one of the first and second opposing surfaces of the second device layers such that the first interface secures together the first and second device layers and also electrically couples the first device layer to the second device layer wherein the conductive interface and the first and second conductive vias form at least a portion of an electrical communication path between the first device layer and the second device layer.

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18. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17 further comprising a first conductive interconnect element disposed in the first device layer with a first portion of the first conductive via electrically coupled to at least a portion of the first conductive interconnect element and a second portion of the first conductive interconnect element coupled to the first doped semiconductor region.

19. (Previously Amended) The multi-layer integrated semiconductor structure of claim 18, wherein the first conductive via couples the first conductive interconnect element to the first conductive interface.

20. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17, wherein the second conductive via is formed on the first one of the first and second opposing surfaces of the second device layer and is coupled to the second doped semiconductor region.

21. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17 further comprising a third conductive via coupled to the second doped semiconductor region.

22. (Previously Amended) The multi-layer integrated semiconductor structure of claim 21 further comprising a second conductive interface disposed on the second one of the first and second opposing surfaces of the second device layer and wherein the third conductive via is provided having a first end coupled to the second doped semiconductor region and a second end coupled to the second conductive interface.

23. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17, wherein the second conductive via is formed on the first one of the first and second opposing surfaces of the second device layer and wherein the second device layer further comprises a first conductive interconnect.

24. (Previously Amended) The multi-layer integrated semiconductor structure of claim 23,

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wherein the second conductive via is provided having a first end coupled to the first conductive interconnect and a second end coupled to the first conductive interface.

25. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17, wherein the first conductive via is coupled to at least the first doped semiconductor region.

26. (Previously Amended) The multi-layer integrated semiconductor structure of claim 25, wherein the first conductive via is provided having a first end coupled to at least the first doped semiconductor region and a second end coupled to the first conductive interface.

27. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17, wherein the first interface corresponds to a first conductor interface region and the multi-layer integrated semiconductor structure further comprises a second interface region disposed between the first one of the first and second device layers with the second interface region provided from a non-conductive material.

28. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17, wherein the first conductive interface region is provided from a conductive bonding material.

29. (Previously Amended) The multi-layer integrated semiconductor structure of claim 18, further comprising a second conductive interconnect element disposed in the second device layer with a portion of the second conductive interconnect element coupled to the second conductive via and wherein the first conductive via, the first conductive interface and the second conductive via provide a direct vertical electrical connection between the first conductive interconnect element and the second conductive interconnect element.

30. (Original) The multi-layer integrated semiconductor structure of claim 17, wherein the first device layer is constructed and arranged to operate using at least one of electronic components, optical components or micro-electromechanical components.

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31. (Original) The multi-layer integrated semiconductor structure of claim 17, wherein the second device layer is constructed and arranged to operate using at least one of electronic components, optical components or micro-electromechanical components.
32. (Original) The multi-layer integrated semiconductor structure of claim 17, wherein the first device layer includes at least one die element.
33. (Original) The multi-layer integrated semiconductor structure of claim 17, wherein the second device layer includes at least one die element.
34. (Original) The multi-layer integrated semiconductor structure of claim 17, wherein the first device layer includes at least one die element of a plurality of die elements located on a semiconductor wafer.
35. (Original) The multi-layer integrated semiconductor structure of claim 17, wherein the second device layer includes at least one die element of a plurality of die elements located on a semiconductor wafer.
36. (Original) The multi-layer integrated semiconductor structure of claim 17, wherein the first device layer includes a first predetermined surface area and the second device layer includes a second predetermined surface area whereby the first predetermined surface area differs from the second predetermined surface area.
37. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17, wherein the first device layer includes a first predetermined surface area and the second device layer includes a second predetermined surface area which is substantially equivalent to the first predetermined surface area.
38. (Previously Amended) The multi-layer integrated semiconductor structure of claim 17, wherein the first device layer further comprises:

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a first conductive interconnect element having a first portion coupled to the first doped semiconductor region, and a second portion coupled to a first end of the first conductive via.

39. (Previously Amended) The multi-layer integrated semiconductor structure of claim 38, wherein the second device further comprises a second conductive interconnect element having a first portion coupled to the second doped semiconductor region and a second portion coupled to a first end of the second conductive via with the second end of the first conductive via and the second end of the second conductive via each coupled to the first interface.

40. (Previously Amended) A multi-layer semiconductor structure, comprising:

- a first semiconductor wafer including a first plurality of semiconductor structures each of which includes a first plurality of semiconductor elements;

- a second semiconductor wafer including a second plurality of semiconductor structures each of which includes a second plurality of semiconductor elements; and

- at least a first conductive bonding interface segment disposed between the first and second semiconductor wafers, said first conductive bonding interface segment disposed over at least a first one of the plurality of semiconductor structures of the first semiconductor wafer and being in an electrical communication relationship with at least a first one of the first plurality of the semiconductor elements of the first semiconductor structure and at least a first one of the plurality of semiconductor elements of the second semiconductor structure of the second semiconductor wafer where the first conductive bonding interface segment permits at least the first semiconductor element of the first semiconductor structure to communicate with at least the second semiconductor element of the second semiconductor structure.

41. (Previously Amended) A multi-layer semiconductor structure, comprising:

- at least a first semiconductor structure including a first plurality of conductive elements;

- at least a second semiconductor structure including a second plurality of conductive elements;

- a first plurality of conductive bonding interface segments disposed between the first and second semiconductor structures with each of the plurality of conductive bonding interface

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segments being in an electrical communication relationship with one or more of the conductive elements of the first semiconductor structure and one or more of the conductive elements of the second semiconductor structure;

at least a third semiconductor structure including a third plurality of conductive elements;
and

a second plurality of conductive bonding interface segments disposed between the second and third semiconductor structures with each of the second plurality of conductive bonding interface segments being in an electrical communication relationship with one or more of the conductive elements of the second semiconductor structure and one or more of the conductive elements of the third semiconductor structure.